CLAIMS

What is claimed is:

1. An apparatus, comprising:

a first component having one or more electromagnetic elements; and

a second component having one or more electromagnetic elements and movably coupled to the first component, wherein:

the second component is adapted to move with respect to the first component in a cyclical manner; and

the one or more electromagnetic elements of the first component are adapted to interact with the one or more electromagnetic elements of the second component during each of one or more cycles of motion of the second component with respect to the first component such that, when a constant force profile is applied to move the second component with respect to the first component, the speed of motion increases and decreases one or more times during each cycle of motion due to different levels of electromagnetic interaction between the electromagnetic elements within each cycle of motion.

2. The invention of claim 1, wherein the levels of electromagnetic interaction are dependent on the direction of the motion of the second component with respect to the first component.

3. The invention of claim 2, wherein the levels of electromagnetic interaction associated with a forward cycle of the motion are different from the levels of electromagnetic interaction associated with a reverse cycle of the motion.

4. The invention of claim 1, wherein, there exists at least one non-constant force profile, such that, when the at least one non-constant force profile is applied to move the second component with respect to the first component, the speed of motion is constant during each cycle of motion due to the different levels of electromagnetic interaction between the electromagnetic elements within each cycle of motion.

5. The invention of claim 1, wherein, when an impulse force is applied to move the second component with respect to the first component, the speed of motion increases and decreases one or more times during a first cycle of motion due to the different levels of electromagnetic interaction between the electromagnetic elements within the first cycle of motion.

6. The invention of claim 5, wherein, when the impulse force is applied to move the second component with respect to the first component, the second component moves with respect to the first component in two or more contiguous cycles of motion, wherein the speed of motion increases and

decreases one or more times during each cycle of motion due to the different levels of electromagnetic interaction between the electromagnetic elements within each cycle of motion.

7. The invention of claim 1, where at least one electromagnetic element has a non-uniform surface texture that is matched to a surface to which it is attached.

8. The invention of claim 1, wherein:
the electromagnetic elements are all passive electromagnetic elements; and
at least one electromagnetic element is a permanent magnet.

9. The invention of claim 1, wherein at least one electromagnetic element is an electromagnet.

10. The invention of claim 1, wherein the second component has one or more low-energy positions during each repetition of motion relative to the first component, wherein each low-energy position corresponds to a peak in overall attractive interaction level between the electromagnetic elements.

11. The invention of claim 10, wherein the second component has two or more low-energy positions that are not equally spaced within each cycle of motion.

12. The invention of claim 1, further comprising one or more prime movers adapted to cause the second component to move with respect to the first component.

13. The invention of claim 12, wherein at least one prime mover is an electromechanical motor.

14. The invention of claim 13, wherein the motor is driven by a DC voltage of about 3V or less.

15. The invention of claim 13, wherein the motor is battery-powered.

16. The invention of claim 12, wherein the at least one prime mover is adapted to cause multiple contiguous cycles of motion having a substantially constant steady-state period of motion for each cycle of motion, during which a profile of the speed of motion within each cycle of motion repeats from cycle to cycle.

17. The invention of claim 16, wherein the profile of the speed of motion involves the speed of the second component increasing and decreasing with respect to the first component within each cycle.

18. The invention of claim 16, wherein electromagnetic interaction between the first and second components reduces variations of speed within the profile of the speed of motion otherwise caused by the prime mover.

19. The invention of claim 12, wherein the apparatus has only one prime mover.

20. The invention of claim 12, wherein the apparatus has two or more prime movers.

21. The invention of claim 20, wherein each prime mover is adapted to move a different component with respect to the first component.

22. The invention of claim 20, wherein each prime mover is adapted to move the second component over a different portion of each cycle of motion.

23. The invention of claim 1, wherein the first and second components are part of a prime mover, wherein the prime mover is adapted to move the second component with respect to the first component.

24. The invention of claim 1, wherein the second component is adapted to move with respect to the first component as a result of external force applied to the second component by a user of the apparatus.

25. The invention of claim 24, wherein the second component is adapted to continue to move with respect to the first component after the external force has been removed.

26. The invention of claim 1, wherein the apparatus is adapted to enable a user of the apparatus to alter the interaction levels between the first and second components.

27. The invention of claim 26, wherein at least one of the electromagnetic elements is adapted to be removed from the apparatus by the user to alter the interaction levels between the first and second components.

28. The invention of claim 26, wherein the apparatus enables the user to change the distance between the first and second components to alter the interaction levels between the first and second components.

29. The invention of claim 1, wherein:

at least one of the electromagnetic elements in one of the components is a magnet; and

at least one of the electromagnetic elements in the other component is an interaction element, wherein:

the interaction element has a material that exhibits at least one of electrical conductivity and magnetic hysteresis; and

the electrical conductivity or magnetic hysteresis or both of the material varies with position over the interaction element, such that, as the second component moves with respect to the first component, the magnet induces at least one of eddy currents and hysteresis forces in the interaction element that vary in intensity during each cycle of motion.

30. The invention of claim 29, wherein the interaction element has one or more cutouts, each cutout corresponding to a position of local minimum interaction level between the electromagnetic elements.

31. The invention of claim 30, wherein the interaction element has a plurality of cutouts.

32. The invention of claim 31, wherein at least two of the cutouts have different dimensions resulting in different local minimum interaction levels and different speeds of motion over each cycle of motion.

33. The invention of claim 29, wherein:

the motion is rotation of the second component relative to the first component; and

the variation in the electrical conductivity or magnetic hysteresis or both of the material results from the interaction element having a non-circular cross-section with respect to a plane perpendicular to the axis of rotation of the second component with respect to the first component, such that the interaction level between the magnet and the interaction element varies over each cycle of rotation.

34. The invention of claim 29, wherein the composition of the interaction material varies with position within the interaction element.

35. The invention of claim 1, wherein each component has one or more magnets whose interaction levels vary over each cycle of motion.

36. The invention of claim 1, wherein the second component is rotatably coupled to the first component such that the cycle of motion corresponds to a complete rotation of the second component with respect to the first component.

37. The invention of claim 1, wherein the second component is rotatably coupled to the first component such that the cycle of motion corresponds to a partial rotation of the second component with respect to the first component.

38. The invention of claim 1, wherein the second component is slidably coupled to the first component such that the cycle of motion corresponds to a complete reciprocation of the second component with respect to the first component.

39. The invention of claim 38, wherein the sliding motion is along a substantially straight line.

40. The invention of claim 38, wherein the sliding motion is along a curved path.

41. The invention of claim 40, wherein the curved path lies substantially within a plane.

42. The invention of claim 1, wherein the second component is slidably coupled to the first component such that the cycle of motion corresponds to a partial reciprocation of the second component with respect to the first component.

43. The invention of claim 1, further comprising at least one more component, wherein the first, second, and at least one more components form at least two pairs of corresponding components, wherein, within each pair, one component is adapted to move with respect to the other component.